# MATERIALS PROCESSING

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## DIAMOND WHEELS FOR MACHINE GRINDING OF HIGH-QUALITY AND ARTISTIC GLASS

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It is shown that optimization of binder hardness and choosing diamond powder with optimal strength and concentration increase the dimensional stability of diamond wheels for use in machining. The new wheels with hardness HB105 – 110 binder with AS50 – AS65 diamond powder at concentrations 100 – 125% have been recommended for commercial use.

***Key words:*** high-quality artistic glass, grinding wheel, concentration of diamond powder, granularity of powder, size stability.

In the world glass industry the fraction of manual grinding of high-quality and artistic glass articles is continually decreasing. Special multispindle profiling machines or CDC machines are used to increase productivity and lower production costs. Several diamond grinding wheels of the same size operate simultaneously on such machine tools. For example, eight wheels operate simultaneously on the German machines manufactured by the Petting Company.

The wheels operating in an automatic regime must satisfy more stringent requirements with respect to dimensional stability than wheels used in manual machining. This is due to the difference in the methods by which the cutting capacity of the wheels is restored after blunting. Wheels for manual machining are manually abraded using electrocorundum abrasive sticks directly on the machine. When wheels operating in an automatic regime become blunt they are removed from the machine and reground with electrocorundum wheels on a universal tool sharpener. The operation of regrinding wheels in one dimension is quite laborious. For this reason, diamond wheels developed for manual grinding under conditions of machine grinding should not be used because of the low dimensional stability and the short period between regrindings.

To increase the dimensional stability of diamond wheels during machining, optimization of the binder hardness and choice of diamond powder with optimal strength, optimal concentration, and optimal coverage was investigated.

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The investigations were performed using a method regulated by GOST 1181–82 on a V3-318E tool sharpener with hydraulic longitudinal feeding. The grinding was performed using 1E1 $100 \times 6 \times 5 \times 90 \times 32$ wheels with AS20 – AS65 (GOST 9206–80) diamond powders with no coating and with 30 and 56% nickel coating on metal binders with HRB85 – 115 hardness and diamond powder concentrations 50 – 125%. Glass bars containing 24% PbO and having dimensions $150 \times 100 \times 20$ mm were ground at the rate 25 m/sec with feed rate 1000 mm/min and grinding depth 1 mm using water-based coolant. The grinding depth was monitored with a height-and-depth gauge with scale division 0.1 mm. The grinding regimes used corresponded to the grinding regimes during the operation of Petting eight-spindle profiling machines. The relative consumption of diamonds was determined according to GOST 16181–82 by weighing on VLT-1-1 balances. Each experiment was repeated at least five times in order to determine the average relative diamond consumption.

The strength of the diamond grains was determined in accordance with GOST 9206–80 on a DA-2M apparatus developed at the Superhard Materials Institute of the Academy of Sciences of Ukraine [1]. A diamond grain was placed between two parallel corundum plates and subjected to uniaxial compression with the load increasing evenly. The force at which failure occurred was recorded. One hundred grains were subjected to failure in order to determine the average value.

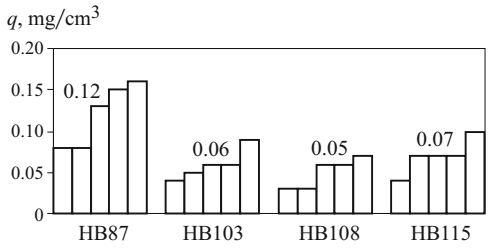


**Fig. 1.** Relative diamond consumption $q$ versus the hardness HB of the metallic binder (AS32 diamond powder with 50% concentration).

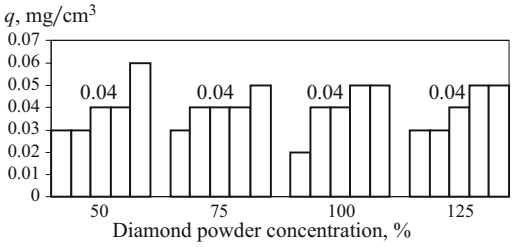


**Fig. 2.** Relative consumption of diamonds $q$ versus the concentration of AS32 diamond powder in binder with hardness HB105 – 110.

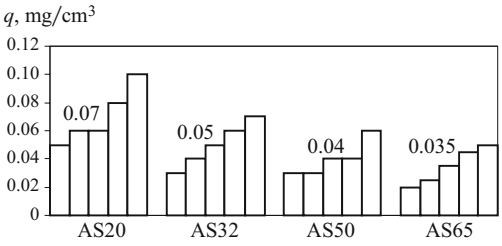


**Fig. 3.** Relative consumption of diamonds $q$ versus the diamond powder brand (diamond powder concentration 50% in binder with hardness HB105 – 110).

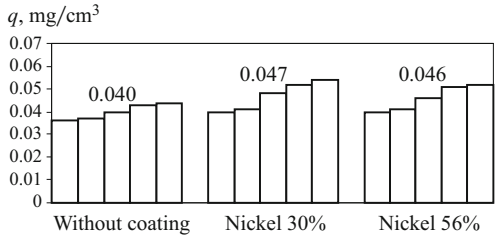


**Fig. 4.** Relative consumption of diamonds $q$ versus the coating of diamond grains (AS50 diamond powder with 100% concentration in binder with hardness HB105 – 110).

The quality of the nickel coating was checked visually using a BIOLAM microscope (× 240) and a volumeter [2].

A model 201 profilograph-profilometer manufactured by the Kalibr Company was used to check the roughness obtained so that a decrease of the relative consumption of the diamonds by optimizing the binder hardness, strength, concentration, and coverage of the diamond powder does not result in higher roughness of the worked surface.

The dependence of the relative consumption of AS32 powder with graininess 53/45 μm on the binder hardness with concentration 50% was constructed to determine the optimal $HV$ hardness of the binder on the diamond wheel (Fig. 1). The binder hardness was increased by changing the copper/tin ratio. The use of a metallic binder with HB105 – 110 hardness as compared with M2-01 binder with HB85 – HB95 hardness made it possible to decrease the relative consumption of diamonds by 50 – 60%. A further increase of the hardness of the binder to HB115 increased the relative consumption of diamond.

The dependence of the relative diamond consumption on the concentration of AS32 diamond powder with 53/45 μm granularity in binder with hardness HB105 – 110 (Fig. 2) was constructed to determine the optimal concentration of diamond powder in a diamond wheel. Changing the diamond powder concentration from 50 to 125% had no material effect on the relative diamond consumption. Therefore, the use of wheels with higher concentration with the same relative wear makes it possible to increase the dimensional stability of the wheels and the time between regrinding as a result of an increase of the amount of diamond powder in the grinding wheel.

The desirability of using harder diamond powders was checked to decrease the relative consumption of diamond grinding wheel when grinding articles made of high-quality and artistic glass [3, 4]. To this end the dependence of the relative diamond consumption on the strength of AS20 – AS65 diamond powder with granularity 53/45 μm in binder with hardness HB105 – 110 and with concentration 50% was constructed (Fig. 3). Analysis of the results showed that the use of stronger diamond powders AS50 – AS65 instead of AS20 – AS32 powders decreases by 25 – 35% the relative consumption of diamonds when grinding article made of high-quality and artistic glass.

The effect of coating diamond powder on the relative consumption of diamonds was also checked. It was determined (Fig. 4) that the use of diamond powder from 30 and 56% nickel coating in wheels for machine grinding did not decrease the relative consumption of diamonds as compared with uncoated powder.

The roughness $R_a$ of the machined surface of glass with binder hardness HB85 – HB115, diamond powder hardness AS20 – AS65, and concentration 50 – 125% with different coatings was measured. Within the experimental limits the factors enumerated had no material effect on the roughness of the machined surface, which fluctuated in the range 1.0 – 1.1 μm.

The new wheels for machine grinding of high-quality and artistic glass with HB105 – HB110 binder with AS50 – AS65 diamond powder with concentration 100 – 125% have

been recommended for commercial use. The new wheels are now operating successfully at seven large enterprises in the Czech Republic, Slovakia, and Poland.

In summary, the new metallic binder with hardness HB105 – 110 as compared with the binder M2-01 decreases the relative consumption of diamonds by a factor of 2 – 3.

The recommended concentration of diamond powder for the production of wheels for machine grinding is 100 – 125%. This makes it possible to increase the dimensional stability of the wheels and the time between regrindings without increasing the relative consumption of diamonds.

The use of AS50 – AS65 diamond powders instead of the powder AS32 makes it possible to decrease the relative consumption of diamonds in machine grinding of articles made of high-quality and artistic glass by 25 – 35%.

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